
# Course Syllabus: MAT 312 – Modern Geometric Theories

**Spring Semester 2011**

**Instructor: Ulrich Hoensch, Ph.D.**

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- Office Hours:
  - Monday 9:45 a.m.-10:45 a.m.
  - Tuesday 1:30 p.m.-2:30 p.m.
  - Wednesday 9:45 a.m.-10:45 a.m.
  - Thursday 1:30 p.m.-2:30 p.m.
  - Friday 9:45 a.m.-10:45 a.m.

  and other times by appointment.

**Class Information**

- Credits: 3 semester hours
- Class Meetings: Monday, Wednesday, Friday 8:45 a.m. - 9:35 a.m.
- Room: Bair Science 102
- Class Web Page: `www.rocky.edu/~hoenschu/SS_2011/MAT312/main.html`

**Text** Greenberg, *Euclidean and Non-Euclidean Geometries-Development and History*, Fourth Edition, Freeman (required). Students are also encouraged to read Doxiadis/Papadimitriou, *Logicomix: An Epic Search for Truth*, Bloomsbury, as a companion text.

**Course Description** This course provides a study of Euclidean and non- Euclidean geometries. Prerequisites: MAT175 and MAT 212.

**Rationale** MAT 312 is a required course for students pursuing a major or minor in mathematics education (the course provides content knowledge in mathematics, as indicated in the RMC Teacher Education Program Conceptual Framework). It is a recommended course for students pursuing a major or minor in mathematics.

**Course Objectives** At the completion of MAT 312, students will be able to:

(1) Trace the development of plane geometry from Euclid to Hilbert.

(2) Use elementary logic in mathematical proofs and apply the rules and syntax of symbolic logic.

(3) Establish geometric results in incidence geometry using the axiomatic method.

(4) Correctly use and communicate the concepts underlying models, consistency and isomorphisms.

(5) Apply the axioms of betweenness, congruence, and continuity.

(6) Establish and apply results in neutral geometry.

(7) Use and prove results for Non-Euclidean geometries.

(8) Work with major models in Non-Euclidean geometry.

(9) Independently read the textbook and apply the knowledge thus acquired.

**Methods of Evaluation** Students will be evaluated based on the following evidence.

- Homework assignments and reading quizzes.
- Attendance record, timeliness, the amount of courtesy and respect extended towards fellow students and the instructor.
- Level of academic and personal honesty and integrity.

**Criteria for Grade Assignment** To receive a passing grade, a student must show evidence that she/he is able to successfully perform the tasks laid out as course objectives (see above). Furthermore, students must attend all class meetings, arrive on time and exhibit appropriate classroom and social behavior. All submitted work must be the student's own work, or if it is not, names of sources or collaborators must be identified.

Possible points will come from:

- Reading assignments which are worth 100 points. Students must read the assigned sections of the textbook prior to each class meeting (see the course schedule below). A take-home quiz covering each reading assignment is due at the beginning of each class meeting.
- Homework assignments which are worth 400 points.

This amounts to a total of 500 possible points. The following grading scale will be used to assign grades. **Note that no "D" grades are given.**

A: 90%, or more B: 80% - 89% C: 70%-79% F: less than 70% of possible points.

**Instructional Methods and Experiences** The format of this class is that of a small-class lecture. Student participation in the lecture is encouraged. Study groups outside of class are strongly recommended. However, completion of homework assignments must be done independently by each student.

**Class Policies** Students are required to attend all class meetings and complete all assignments. All homework assignments must be submitted at the beginning of class on the due date. Late homework will not be corrected and will receive no credit, regardless of circumstances or personal emergencies. Other in-class assignments, including tests and exams, must be completed in the time allotted by the instructor. All work on tests and exams must be the student's own work, and

may only be obtained through the use of allowed tools. Homework assignments must be completed independently by each student. Tests and exams may only be made up if the instructor is notified in advance of qualified absences. Qualified absences are limited to the following: (a) activities connected with Rocky Mountain College programs; (b) grave illness (in which case a doctor's note is required); (c) a family or personal emergency, or due to force majeure. In case (a), students must inform the instructor prior to their absence. In cases (b) and (c) above, students may be excused from assignments if they notify the instructor immediately after their absence.

**College Academic Policies** Students must abide by all Academic Integrity Policies of the College. See `http://www.rocky.edu/index.php?type=academics&ct=policies` for details.

| Date | Reading | Topics |
|---|---|---|
| Mon Jan 10 | p.1-15 | Axiomatic Method/Undefined Terms |
| Wed Jan 12 | p.15-23 | Euclid's First Four Postulates |
| Fri Jan 14 | p.23-40 | Straightedge-and-Compass Constructions |
| Wed Jan 19 | p.53-68 | Elementary Logic and Proofs |
| Fri Jan 21 | p.69-71 | Elementary Logic and Proofs |
| Mon Jan 24 | p.72-79 | Incidence Geometry |
| Wed Jan 26 | p.79-82 | Models |
| Fri Jan 28 | p.82-83 | Isomorphism of Models |
| Mon Jan 31 | p.84-86 | Affine and Projective Planes |
| Wed Feb 02 | p.87-91 | Affine and Projective Planes |
| Fri Feb 04 | p.103-111 | Affine and Projective Planes |
| Mon Feb 07 | p.111-115 | Axioms of Betweenness |
| Wed Feb 09 | p.116-119 | Axioms of Betweenness |
| Fri Feb 11 | p.119-122 | Axioms of Betweenness |
| Mon Feb 14 | p.122-126 | Axioms of Congruence |
| Wed Feb 16 | p.126-129 | Axioms of Congruence |
| Fri Feb 18 | p.129-132 | Axioms of Congruence |
| Mon Feb 21 | p.132-135 | Axioms of Continuity |
| Wed Feb 23 | p.135-138 | Axioms of Continuity |
| Fri Feb 25 | p.138-144 | Axioms of Continuity |
| Mon Mar 07 | p.161-164 | Hilbert's Euclidean Axioms of Parallelism |
| Wed Mar 09 | p.164-168 | Alternate Interior Angle Theorem |
| Fri Mar 11 | p.169-173 | Exterior Angle Theorem |
| Mon Mar 14 | p.173-176 | Measure of Angles and Segments |
| Wed Mar 16 | p.176-183 | Equivalence of Euclidean Parallel Postulates |
| Fri Mar 18 | p.183-191 | Saccheri and Lambert Quadrilaterals |
| Mon Mar 21 | p.209-219 | Angle Sum of a Triangle |
| Wed Mar 23 | p.219-227 | History of the Parallel Postulate |
| Fri Mar 25 | p.239-249 | History of the Parallel Postulate |
| Mon Mar 28 | p.249-254 | Discovery of Non-Euclidean Geometry |
| Wed Mar 30 | p.254-260 | Non-Euclidean Hilbert Planes |
| Fri Apr 01 | p.260-267 | Non-Euclidean Hilbert Planes |
| Mon Apr 04 | p.289-293 | Non-Euclidean Hilbert Planes |
| Wed Apr 06 | p.293-301 | Consistency of Hyperbolic Geometry |
| Fri Apr 08 | p.302-308 | The Beltrami-Klein Model |
| Mon Apr 11 | p.308-311 | The Poincaré Models |
| Wed Apr 13 | p.311-313 | Perpendicularity in the Beltrami-Klein Model |
| Fri Apr 15 | p.313-322 | A Model of a Hyperbolic Plane from Physics |
| Mon Apr 18 | p.322-333 | Inversion in Circles, Poincaré Congruence |
| Wed Apr 20 | p.333-341 | Inversion in Circles, Poincaré Congruence |
| Wed Apr 27 | p.341-348 | The Projective Nature of the Beltrami-Klein Model |
| Fri Apr 29 | | The Projective Nature of the Beltrami-Klein Model |

**OPI/PEPPS Standards**

| Standard | Course Objective |
|---|---|
| **10.58.518 Mathematics** | |
| (1) The program requires that successful candidates: | |
| (3) demonstrate content knowledge in: | |
| (c) geometries by using spatial visualization and geometric modeling to explore and analyze geometric shapes, structures, and their properties; | (3), (4), (6), (7), (8) |
| (g) measurement by applying and using measurement concepts and tools. | (4), (5), (6) |